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AUTHOR Batey, Anne; And Others
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ABSTRACT

The instructional uses of databases are highlighted in this report and their advantages as teaching and learning tools are emphasized. Databases reviewed are for storing, retrieving, sorting, and printing information and for manipulating information. Questions explored include: (1) how are science databases used in the classroom (covering building, designing, and using a database); (2) what are the advantages and disadvantages of using databases; (3) what science database software is available (reviewing the types of database software and providing a list of products and descriptions of data files and dedicated databases); and (4) what are the technical capabilities of science database software (describing the capabilities in terms of searching, fields, records, reporting and sorting). Producer information is provided and consists of addresses and phone numbers of the companies. (ML)

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THE Northwest Regional Educational Laboratory

TECHNOLOGY PROGRAM

A REVIEW OF DATABASE SOFTWARE FOR SCIENCE

A MicroSIFT Quarterly Report

November 1986

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
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by

Anne Batey
Sharon Mater
Kathleen Nolf
Dave Weaver

Technology Program

Northwest Regional Educational Laboratory
300 S.W. Sixth Avenue
Portland, Oregon 97204

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WHAT IS THIS REPORT ABOUT?

This MicroSIFT Quarterly Report is about a tool for teaching and learning to think--the database.

First, a short quiz about planets--

1. What is the average temperature of the planet Jupiter?

   You probably do not have an exact figure in mind just now, but you are sure you could find it in an encyclopedia. Early in their schooling, students learn where to get information like this.

2. What planets have an average temperature hotter than Jupiter?

   This question is trickier because you would need information on all the planets before choosing those that are hotter than Jupiter. Again, this is a task that students can do with some reasoning skills and an encyclopedia.

3. When the planets are arranged in order of increasing distance from the sun, is there a pattern in their surface temperatures? If so, what is it? Is there a relationship between temperature and distance from the sun? Explain.

   Now, those of you who think carefully and quickly may already have an answer. The rest of us would probably have to arrange the planets as stated and then look at the numbers for temperature before we had an answer and an explanation. The answer to this kind of question is not easily pulled from an encyclopedia; it requires students to use those elusive higher level thinking skills.

Databases provide an exciting instructional use of computers because they make it easy to store, retrieve, sort and display information. When information is easy to manipulate, students can make sense of it more easily. Throughout this report, we think of databases as having two components: the database manager for storing, retrieving, sorting and printing information and the data or the information manipulated by the database.

HOW ARE SCIENCE DATABASES USED IN THE CLASSROOM?

Database activities can be grouped into three areas: using, building and designing.

Using a database--It is best to introduce students to the concept and capabilities of a database with activities that use an existing database. Such activities can range from simple to complex:

- **Information retrieval.** At the simplest level, the database can be used as an information resource. For example, a database of wildflowers could be used to identify all yellow wildflowers found in western North America.

- **Recognizing patterns and trends.** Students might examine a database on trees and observe that trees native to colder climates and higher altitudes have a smaller maximum height.

- **Analyzing relationships.** Students can examine a database on planets to determine the relationship between mean temperature and the distance from the sun.

- **Testing hypotheses.** A database on climate might be searched to test the hypothesis that areas of highest rainfall usually border oceans.

- **Interpreting the data.** A database of elements could be sorted by atomic number, and when compared to sorts by atomic mass and number of protons students can infer the meaning or origin of atomic number.

- **Thinking Critically.** Using a database on pesticides, students could compare the advantages and disadvantages of each in order to choose the best pesticide alternative.

A database can be used in any classroom setting. With the whole class the teacher can facilitate an exploration of the database using a large screen monitor. Small groups can work at one or more stations or students can work individually in a computer lab.

Building a database--After students have used databases, they can develop research skills and work cooperatively by collecting and entering the information for a database. The tasks involved include:

- Researching and collecting the information specified in the database design

- Verifying the data for accuracy and consistency in terminology

- Entering and editing the data

- Modifying and debugging the database design

In building a database, all records must be entered into one file. One way to do this is to designate a computer station for data entry. All students enter their data in one master file on a single disk that is backed-up FREQUENTLY. Another method involves students doing the data entry at several work stations on several disks. When each student has completed his/her data entry, the records are copied onto a master file disk.

Designing a database--When students are familiar with the concept of a database, they are prepared to design their own. The list of activities below describes the sequence generally followed when creating a database with students.

- Clearly define the class of information to be contained in the database, i.e., define what makes up a record
- Conduct research to identify what information is available on the topic
- Examine the data for commonalities and differences
- Define the fields or categories which make up the records
- Define the vocabulary and format of the fields
- Create the forms on the computer as well as printed data entry forms

In a classroom setting, these activities could involve an entire classroom in the design of a single database, or the class could work in small groups designing several databases. Databases could also be designed individually by more advanced students.

WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF USING DATABASES?

Teachers familiar with the instructional use of databases have identified the following advantages:

- One database manager can be used in a wide variety of science topic areas and levels.
- Using a science database for information processing is a real world application of the computer which cannot be performed using other media.
- A database activity provides a rich environment for developing higher level thinking skills.
- The activities are motivating because students control the use of information.

The disadvantage is in managing a database activity; it requires a significant amount of planning and background work. Teacher preparation includes:

- Learning the database manager prior to classroom use
- Disk handling and making back-ups
- Providing information resources for building the database

WHAT SCIENCE DATABASE SOFTWARE IS AVAILABLE?

There are three types of database software of interest to science teachers.

1. Database Managers (DBM) are simply the computer programs which store and retrieve information. While there are several hundred database management packages available, most are designed for home or business. A few of these are used in the classroom because they are easy to use, they are reasonably priced, or it is possible to purchase compatible data files appropriate for instruction. This report features six database managers which have science data files available.

2. Data Files are collections of information on specific topics, usually on separate disks. For example, there are several data disks available which contain data on the elements. To use a data disk, you must have the DBM software for which the data disk was designed. This report features nine science data file packages.

3. Dedicated Databases include both the database management software and data files. However, the database manager is dedicated to managing the accompanying set of data and could not be used to create a database. There are three dedicated databases featured in this report.

Table 1 on the next page gives a list of products identified at the time of publication. Brief descriptions of the data files and dedicated databases follow the table. The technical features of the database managers are compared in the final section of this report.

TABLE 1: PRODUCT DESCRIPTIONS

TITLE	PRODUCER	COST	HARDWARE	LEVEL	TOPIC	OTHER SOFTWARE
DATABASE MANAGEMENT PACKAGES						
AppleWorks	Apple	250.00	AP	4-12	NA	None
Bank Street School Filer	Sunburst	99.00	AP CO	4-12	NA	None
FileVision	Telos	78.00	MC	7-16	NA	None
Friendly Filer	Grolier	54.95	AP CO IB	4-12	NA	DOS for IBM
MECC Dataquest: The Composer	MECC		AP	5-12	NA	None
Scholastic PFS:file series	Scholastic		AP IB	7-12	NA	DOS for IBM
DATA DISKS						
Animal Life Databases	Sunburst	59.00	AP CO	4-8	Animals	Bank Street
Climate and Weather	Scholastic	79.95	AP	7-12	Weather	AppleWorks
Databases in the Classroom: Science	MECC	49.00	AP	6-12	Science	AppleWorks, MECC
Endangered Species	Sunburst	59.00	AP CO	4-8	Species	Bank Street
Life Science Databases	Scholastic	99.95	AP IB	6-12	Life Sci.	PFS:file, report
Physical Science Databases	Scholastic	99.95	AP IB	6-12	Phys Sci.	PFS:file, report
Public Domain Data Files, FileVision	Telos	1.50ea	AP	various	various	FileVision
Science Files	John Hayes	22.00	AP	7-12	Science	FileVision
Science and Nature Facts	Grolier	16.95	AP CO IB	3-9	Science	Friendly Filer
DEDICATED DATA PACKAGES						
Classification	MECC	29.00	AP IB	6-9	Animals	None
Holt Science Processors	Holt		AP	1-6	Science	None
Information Lab: Life Science	Add-Wesley	69.95	AP	7-10	Life Sci.	None

HARDWARE KEY: AP - Apple, CO - Commodore, IB - IBM, MC - MacIntosh
TOPIC KEY: NA - Not Applicable

Software Descriptions: Data Files

Animal Life Databases (Sunburst; $59.00). This good introductory database for younger students (fourth grade) may easily be adapted for use through twelfth grade. This is a collection of seven databases which are used independently. The first file, "Animals," lists data for 60 animals. Two other files, "Warm" and "Cold," divide the animal file between warm- and cold-blooded animals. Other files include "Books," "Glossary" and "Pets." Students may add data to these files. The "Lab" file allows students to research and analyze an experiment on the eating habits of land snails. The comprehensive 112-page Teacher's Guide provides teacher instructions, descriptions of the animals included, sample records, student activity sheets and answer key. These databases are used with Bank Street School Filer, and assume students have a basic understanding of how to use it.

AppleWorks Data Bases: Climate and Weather (Scholastic; Apple; $79.95). These two learning units, based on complete databases, "Weather" and "Local Climate," may be used independently of each other. Seventy-seven locations are featured, covering a wide variety of land areas in the United States. Using the database and spreadsheet tools of AppleWorks, students test their own hypotheses on the relationships between geographic features (e.g., latitude, longitude, altitude, bodies of water, mountains) and weather (e.g., precipitation, relative humidity, cloud cover, wind, barometric pressure, temperature). There is an optional generalized lab experiment template. The database is open-ended; students are urged to create their own database building on the existing. Printed materials include self-study units which teach AppleWorks skills. The "Climate and Weather" units make use of the AppleWorks spreadsheet. It would be helpful for the teacher to have a working knowledge of AppleWorks, and a general understanding of databases prior to introducing to a class. A comprehensive teacher's manual gives learning activities which would make it easier for the novice to use successfully. This database is designed for use in grades 7-12.

Databases in the Classroom: Science (Minnesota Educational Computing Corporation; Apple; $49.00). This is a large collection of data files on many subjects. It includes four on science topics: "Elements," "Mammals," "Creatures" and "Parasites." The Mammals file lists 140 animals, giving the infraclass, order, family, genus and species. This database has two versions to use with AppleWorks or DataQuest Composer. For use with grades 6-12, the supplementary materials include suggested lesson plans and activity pages.

Endangered Species (Sunburst; $59.00). These six files about endangered and extinct animal species use Bank Street School Filer and assume the student has a basic understanding of it. The files, which may be used independently, include "Mammals" (44 animals listed by the U.S. Fish and Wildlife Service under the United States Endangered Species Act), "Critical" (40 of the most endangered species), "Extinct" (202 records of extinct birds, animals and reptiles), "Glossary" (48 terms used in these databases) and "Books" (35 books about endangered animals). In "Books" students are encouraged to add fiction and nonfiction books. The sixth file, "Local," allows students to enter records of local threatened or endangered animals. Printed materials include ways to locate data for this file. These databases, while written for the junior high level, may be easily adapted for use in grades 4-12.

Life Science Databases for PFS:file (Scholastic; Apple, IBM; $99.95). These comprehensive files allow students to study relationships among the characteristics and environments of living organisms using PFS:file. There are three large, independent data files on Bird Migration, Animals and Animal Biological Systems. "Bird Migration" includes over 230 birds and information on their migratory status, arrival and departure dates, habitats, and major food sources. The file is designed so students can later add data on birds that are found throughout the year in their local area. Because the files are very large, searches can take a long time. The files are unprotected and it is easy to change the data without intending to. Each data file has a supplementary printed unit of eight to ten activities. There are two other suggested databases, "Wildflowers" and "Drugs." Extensive teacher supplementary material supports all levels of database use--including designing, creating, and updating the existing files. The printed units begin with lessons suitable for a sixth grader, progressing to lessons suitable for a 12th grader. Printed material help the teacher and student operate PFS; however, the producer suggests the teacher have a working knowledge of PFS prior to beginning the activities. Assignments using PFS:report allow students to print information which makes finding patterns and relationships easier.

Physical Science Databases for PFS:file (Scholastic; Apple, IBM; $99.95). Three data files include "Chemical Elements," "Common Substances" and "Chemical Tests." The latter two files are designed so that students can add other substances and tests that are of interest to them. "Common Substances" investigates the properties of over 70 substances from white pine to natural gas and the relationship among them. Data includes boiling and melting points, color, odor, heat content, hardness, and common uses. Supplementary text guides students in creating two additional files: "Glues and Adhesives" and "Stains and Solvents." Use PFS:file; PFS:report is used in many activities. Files are unprotected and it is easy to change data without intending to. Extensive teacher supplementary materials will support all levels of database use. Each file has a supplementary printed unit of eight to nine activities which allow for a wide range of grade and skill levels, progressing from grade six to grade twelve. The teacher, however, should have a good working knowledge of PFS:file and PFS:report before introducing to the class.

Public Domain Data Files—FileVision (Telos Software Products; Macintosh; $1.50 per data file). Telos Software Products maintains over 100 public domain datafiles. Out of these, at least 13 are data files of interest to science teachers. These include such topics as: "Meiosis" (showing the division of cells with data about each phase), a periodic chart of the elements, "Galaxies," an archaeological dig, or an eye diagram. One file called "Shoulder" is a diagram of the shoulder with data on the labeled parts; it would be useful in a health unit covering sports injuries. The inclusion of visual information as part of the data gives meaning to the cliche "A picture is worth a thousand words." The data files contain varying amounts of text information. Some are complete information systems and others are templates requiring that students enter much of the information. Contact the producer for a catalog of files, then pay for only those you want. You must be a registered FileVision owner.

Science Files—FileVision (John Hayes; Macintosh; $22.00). This is a collection of 17 science data files created by a science teacher. The files take advantage of FileVision's incredible graphics capabilities, providing highly detailed charts, maps and diagrams as part of the data files. The files cover such topics as: "Astronomy," "Earth's History," "Evolution of Earth's Continents," "Wind Currents," "Earthquakes," "Faults," "Volcanoes and Hot Spots," "Periodic Table," "Transuranic Elements," "Electrons and Orbitals." Each file contains visual data as well as print information. Each file can be expanded and adapted to suit individual needs. The graphics may be reused in new files. Designed for use in grades seven through twelve.

Science and Nature Facts: Friendly Filer (Grolier; Apple, Commodore, IBM; $15.95). This one includes four databases--"Manned Spaceflight," "Space and Nature Reading Guide," "Mammals of North America," and "Wildflowers of North America." A limited amount of information may be added to any of the files. "Manned Spaceflight" lists 105 spaceflights by mission name, country of origin, launch data, touchdown data, and a notable event from each of the flights. One file, "Space and Nature Reading Guide," could be a good classroom resource. It describes more than 50 books on spaceflight, animals and wildflowers. Students could add book information from their school's library. These databases are for grades three through nine and use Friendly Filer. The databases are extremely easy for children to use, but rather limiting for what an older student may wish to explore.

Software Descriptions: Dedicated Databases

Classification (Minnesota Educational Computing Corporation; Apple, IBM; $29.00). This dedicated database, for grades 6-9, relates to animals in particular but could be used with other topics dealing with information, storage, classification and retrieval. Three basic lessons are found in the supplementary materials--lesson one classifies animals; lesson two identifies animal attributes; and lesson three creates and uses a database called Classlist, in which students enter information about themselves. The lessons emphasize database organization and function. The total amount of information in a file is somewhat restricted by the database manager.

Holt Science Processors (Holt, Apple). This package is scheduled for release in mid-1987. A dedicated database for grades 1-6, topics include animals, solar system, food and nutrition, and chemistry. Possible activities: What did I just eat (illustration of nutrient graph inside stomach outline)? Create an animal. How much do you weigh on Saturn? Features traditional database functions plus special built-in tools, such as the ability to graph. In addition to a user's manual, there is a book for each of the six grades. Teacher plans and reproducible worksheets are included. (Publisher's description)

Information Laboratory: Life Science (Addison-Wesley; Apple; $69.96). This dedicated database takes an unusual approach to searching and sorting; students access the data as they would from a library card catalog system. They can view individual cards of information or look up systems such as cell biology, ecology, human anatomy, heredity or microorganisms. The information can also be sorted by decks, like a deck of cards, creating new groupings on minisubjects. There are predefined decks or students can create their own. The data has been sorted to parallel the chapters in the accompanying workbook. To help the student work with the database, there is an extensive set of searchsheet masters. Information cannot be added to the database.

WHAT ARE THE TECHNICAL CAPABILITIES OF DATABASE SOFTWARE?

Table #2 (on page 12) identifies the technical capabilities of the database managers and the dedicated databases. The data disks inherit the capabilities of their respective database manager. Below is an explanation of each capability.

Searching Capabilities--These items cover the ability to search for and retrieve the information stored in the database.

- **Speed**--Does the database manager complete searches or sorts quickly or slowly?
- **And**--Is it possible to search using more than one parameter connected by the AND logical connector? For example, could an "elements" file be searched for all which have two outer electrons and have more than two shells?
- **Or**--Can a search use more than one parameter connected by the OR logical connector? For example, could an "elements" file be searched for all which have high electrical and thermal conductivity?
- **Not**--Can the package search for all except a given parameter? For example, could an "elements" file be searched for all nonmetals?
- **Partial**--Is it possible to search for a word or part of a word that is somewhere in the middle of the field?
- **Less Than, Greater Than, Not Equal To**--Can a search request a value less than, greater than, or not equal to a given number?
- **Range**--Can a search request values between two given numbers?

Fields--These items cover fields or categories and the ability to modify them after data has been entered.

- **Max/Record**--What is the maximum number of fields per record?
- **Max Length**--What is the maximum number of characters that can be added per field?
- **Name Length**--What is the maximum length of the field name?
- **Rename**--Can the field names be renamed without losing data?
- **Add**--Can fields be added without losing data?
- **Delete**--Can fields be deleted without losing data in the other fields?

- **Move**--Can the location of the fields on the screen be changed?

- **Calculated**--Can fields be calculated from the contents of other fields?

Records--These items cover the records contained in a file.

- **Max/File**--What is the maximum number of records in a file?

- **Add**--Is it possible to add records to the file?

- **Delete**--Is it possible to delete records from the file?

- **Copy**--Is it possible to copy records from a file on one disk to a similar file on another disk? (This is important to educators who may wish to collect the records made by students working at different machines using several data disks onto one master data disk.)

Reporting--These items cover the printed reports.

- **Label**--Is it possible to print labels (example: mail labels)?

- **Table**--Is it possible to print tables or columns of information?

- **Graphing**--Is it possible to display or print graphs?

- **Total**--Is it possible to calculate the total for a column of numbers?

- **Average**--Is it possible to calculate the average for a column of numbers?

- **Count**--Can a report give the count for the number of records included?

- **Derived**--Can a report include information which is calculated or derived from other fields?

Sorting--These items cover sorting capabilities.

- **Levels**--How many levels of sorting are possible? For example, a database manager capable of sorting on two levels could sort an "elements" database numerically by atomic number first and then within those groups, numerically by atomic mass.

- **Optional Order**--Is there a choice between ascending or descending order?

TABLE 2: TECHNICAL CAPABILITIES

		Searching								Fields								Records				Reports							Sorting	
DATABASE MANAGERS	PRODUCER	Speed	And	Or	Not	Partial	Less Than	Greater Than	Not Equal To	Range	Max./Record	Max. Length	Name Length	Rename	Add	Delete	Move	Calculated	Max./File	Add	Delete	Copy	Label	Table	Graphing	Total	Average	Count	Derived	Levels	Optional Order
AppleWorks	Apple	F	Y	Y	Y	Y	Y	Y	Y	Y	20	79	20	Y	Y	Y	Y	N	L	Y	Y	Y	Y	Y	N	Y	N	N	Y	U	Y
Bank Street School Filer	Sunburst	F	Y	Y	Y	Y	Y	Y	Y	Y	50	95	15	Y	Y	Y	Y	Y	L	Y	Y	Y	Y	Y	N	Y	Y	N	N	4	Y
FileVision	Telos	S	Y	Y	Y	Y	Y	Y	Y	Y	L	U	15	Y	Y	Y	Y	N	999	Y	Y	Y	Y	Y	Y	N	N	N	N	1	N
Friendly Filer	Grolier	S	Y	N	N	Y	N	N	N	N	7	37	20	N	N	N	N	N	360	Y	Y	N	Y	N	N	N	N	N	N	1	N
MECC Dataquest: The Composer	MECC	F	Y	Y	N	N	Y	Y	Y	Y	U	U	60	Y	Y	Y	Y	N	250	Y	Y	N	Y	Y	N	Y	N	N	N	U	Y
Scholastic's PFS:file	Scholastic	S	Y	N	Y	Y	Y	Y	Y	Y	U	U	U	Y	Y	Y	Y	L	L	Y	Y	Y	Y	N	N	N	N	N	N	1	N
DEDICATED DATABASES	PRODUCER																														
Classification	MECC	F	N	N	N	Y	N	N	N	N	6	9	9	N	N	N	N	N	200	Y	Y	N	Y	N	N	N	N	N	N	1	N
Holt Science Processors	Holt**																														
Info Lab: Life Science	Add-Wesley	S	Y	Y	N	N	N	N	N	N	NA	NA	NA	NA	NA	NA	NA	NA	700	N	N	N	Y	N	N	N	N	N	N	1	N

KEY:
Y - Yes, N - No, U - Unlimited, L - Limited (See Description), NA - Not Applicable, F - Fast, S - Slow

**This package was not available for review at the time of publication.

PRODUCER INFORMATION

Addison-Wesley
2725 Sand Hill Road
Menlo Park, CA 94025
415/854-0300

Apple Computer, Inc.
20525 Mariana Avenue
Cupertino, CA 95014
408/973-3850

D.C. Heath Software
125 Spring Street
Lexington, MA 02173
800/225-1149

Grolier Electronic Publishing, Inc.
Sherman Turnpike
Danbury, CT 06816
800/858-8858

John Hayes
Colegio Roosevelt
Apartado 247, Miraflores
Lima 18, Peru

Holt, Rinehart and Winston
CBS Educational and Professional Publishing
383 Madison Avenue
New York, NY 10017
212/872-2000

Minnesota Educational Computing Corporation
3490 Lexington Avenue North
St. Paul, MN 55126
612/481-3500

Scholastic Software
2931 East McCarty Street
P.O. Box 5702
Jefferson City, MO 65102

Sunburst Communications
39 Washington Avenue
Pleasantville, NY 10570-9971
800/431-1934

Telos Software Products
3420 Ocean Park Blvd.
Santa Monica, CA 90405
213/450-2424
800/554-2469